DOCUMENT RESUME

ED 078 465 CS 500 307

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TITLE System Models of Information, Communication and Mass Communication: Revaluation of Some Basic Concepts of Communication.
PUB DATE Apr 73
NOTE 23p.; Paper presented at the Annual Meeting of the International Communication Assn. (Montreal, April 25-28, 1973)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Communication (Thought Transfer); Communications; Communication Skills; Cybernetics; Films; Information Science; Information Systems; *Information Theory; *Mass Media; *Models; Nonverbal Communication; Systems Analysis; *Systems Approach; Systems Development; Television
IDENTIFIERS *Open and Closed Systems

ABSTRACT

A more unified approach to communication theory can evolve through systems modeling of information theory, communication modes, and mass media operations. Such systematic analysis proposes, as is the case care here, that information models be based upon combinations of energy changes and exchanges and changes in receiver systems. The mass media is particularly exemplary as a model for such methodological procedure. (CH)

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INTERNATIONAL COMMUNICATION ASSOCIATION
Annual Conference
MONTREAL, April 25-28, 1973

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SYSTEM MODELS OF INFORMATION, COMMUNICATION AND MASS COMMUNICATION: Revaluation of Some Basic Concepts of Communication

Helsinki, Finland, 1973

ED 078465

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1.0 Information Processing

Anybody who has taught communication has had difficulties with definitions. For example: what is information? Most writers take information for granted without even trying to define the concept. Some writers start with Shannon's mathematical theory of signal transmission but after paying tribute to Shannon, Wiener and Weaver they forget the theory conveniently and use it never again in the analysis of human communication. It is not implied that the theory should be used: the point is rather that there is no logical or unified frame of reference where to put the mass of abstract ideas and empirical evidence listed under the heading of human communication or human information processing. Maybe this is why there has been no book which could be called a logical "introduction to human communication".

The suggestion for a frame of reference in human communication presented here grew up from teaching communication and organization theory. In organization theory many writers have used the general system theory as a frame of reference for organizational analysis. It is a small wonder that so little has been written about the use of system theory to describe human communication. After all - communication theory - if it exists - and general system theory have a common ancestor in Norbert Wiener.

The models described here are based on the system theory.

1.1 Systems

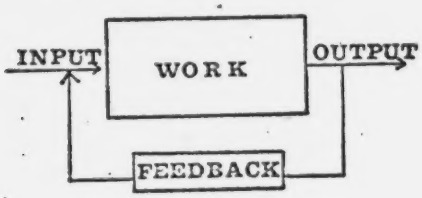
A system is a set of objects together with relationships between the objects and between their attributes

(Hall & Hagen, 1956).

Open systems exchange material, energy and/or information with their environment; with closed systems no such exchange takes place. The functions of an open system are unpredictable and predictable in a closed system. Organic systems are open systems because they are dependant on their environment and they can behave in an unpredictable way.

A system can be divided into subsystems: a biological system may have a control subsystem, a sensor subsystem, a blood subsystem etc.

All open systems have some common properties, notably the through-put of the system. They receive energy, matter and/or information (input), process it (work) in cycles into a different form and export it (output) into the environment. Open systems also receive information from the environment to regulate the input and output of the system (feedback).



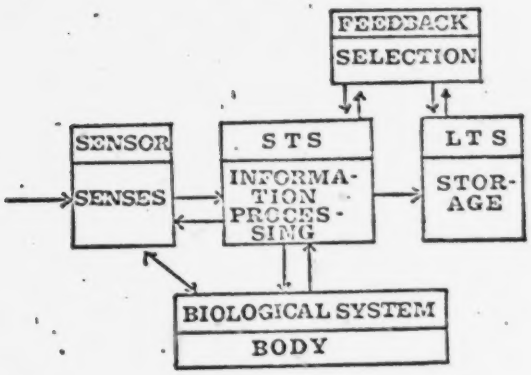
An open system

Control systems

In our model of information and communication processes the control system of a system is an essential part. The control system is a subsystem or a system which regulates and controls the work processes of a system or another system. In a car the steering system, the clutch, the brake and the gas systems form the control system.

In a human being the brain, the nervous system and the senses constitute the control system. This

system controls the actions of human beings in a rather complex way. Energy changes from the environment activate the sensory system which transfers the input impulses in an electro-chemical process into the short term store or short term memory, which, perhaps, is also our "consciousness". The short term store (STS) is a temporary working memory with a limited information handling capasity: according to Miller (1956) it can process at most 10 bits simultaneously.



The human control system

If the incomming signals are accepted they can cause action in the body functions and/or be transferred to the long term store (LTS) or long term memory. The process is probably electro-chemical in nature: electric pulses induce permanent chemical memory images in LTS. The choice of transferred images from STS into LTS is controlled by the feedback selection system.

Miller (1956) has shown that language is processed in "chunks" of about 5-9 words. This fits very well into the two-component model of the memory process. Words are collected into STS to its full capasity, then this "chunk" is processed and transferred into LTS or rejected. It seems probable that what is transferred is not separate words but ideas, meanings, which are expressed in thought units, grammatical combinations as explained by Chomsky.

1.2 What is information?

The mathematical theory of information (Shannon, 1948) and the semantic information theory (Carnap & Bar-Hillel, 1952, 1964) leave much to be desired as explanations of what information really is. They are operational only in limited areas of research and there is much ambiguity in the use of the information concept.

It must, however, be remembered that Shannon never intended his theory to be anything else than a theory of signal transmission. His co-author Weaver stated that:

> "..information must not be confused with meaning.""That is, information is a measure of one's freedom of choice when one selects a message."

The proper name, actually, for Shannon's theory should be Theory of Signal Transmission.

Semantic Information Theory or, better, Theory of Semantical Content as presented by Carnap and Bar-Hillel is concerned with meaning. Its operationality is, however, limited by the formal requirements of the logical analysis of the theory. On the other hand, not all information is semantic and this again limits the use of the theory.

There are several ways the concept of information has been approached. Some of the more pragmatic definitions convey very little information: they more or less say that information is information or that information is something which is relevant.

There does not seem to be any agreement whether information is an abstraction or something "real". It is often stated that information is something which does this and that. Some quotations:

> Hans Hörmann, (1971):
> "The notion of information belongs, therefore, to the area of abstractions in which the concepts of language or of grammar are located...""Information is structure. Carrier of this structure may be printers ink, sound waves or electric impulses."
>
> Zločevskij & Kozenko & Kosolapov & Polovinčik (1972):
>
> "Information is a state of any material system ..."
>
> Brillouin (1963):
>
> "We define 'information' as the result of choice, we do not consider 'information' as a basis for a prediction of a result that could be used for making another choice. We completely ignore the human value of information..."
>
> MacKay (1968):
>
> "The amount of information received by an organism can then be measured (in various ways) by measuring if we can (in various ways) the logical (organizing) work it does for the organism..."

Sometimes information means a choice or a structure, it can mean the content of the message and the message itself and even the transmission of the message. It would seem that much could

be gained already by an agreement about the proper use of the term.

Commonsense analysis of "information" clarifies the concept in some degree. According to the mathematical information theory the more unexpected a given choice is the more information there is. Thus it would seem that an Eskimo word in this text would be most unexpected but it is doubtful whether it would give any information whatsoever. On the other hand there is no doubt that a red light at a street corner gives much information to a car driver, but according to the Semantic Information Theory the red light does not contain any information without further logical conditions.

Information seems to be always a relative concept: if something is known then there is little information. There seems to be an agreement that information is among other things a measure of uncertainty. Thus information is dependent on the receiver of the information. Therefore it would seem that a statement that information is structure or a state is not enough. Somebody must receive a desription about the structure or the state. This would leave open the question of whether there could be information through thought process and about abstractions without correspondence in reality.

A definition of information as a state or a structure is redundant. It does not add anything to the concepts of a state or a structure; in fact there seems to be a complete tautology.

If we analyze the process of information, there is always one thing in common: the use of energy. Although Wiener (1948) said "Information is information, it is neither matter nor energy", "common sense" would see changes in energy in all the cases we are willing to accept the existence of "information". Our model is based on this fact.

A System Model of the Information Process

The General System Theory offers a new approach for the analysis of the information concept. The present model is a FUNCTIONAL MODEL OF THE INFORMATION PROCESS based on the input-work-output-process of an open system. The main goal in the development of the model has been its operationality in the further analysis of HUMAN COMMUNICATION.

The main conditions for the model are:

1. Information is always connected to the use of energy.
2. Information is always dependant on the receiver; there can be no information process without a system to receive the information.
3. Information means changes in the state of the receiver system.
4. The value of the information for the receiver system is not independent of the time the information is available in the system.

Using these conditions we put forward a model of the information process as a system in several propositions.

Proposition 1

Information is a change in energy which causes a work cycle of the control system as the input-work-output-feedback-process of an open system.

According to the model information is such a change in energy which causes changes in a control system. Thus information is not energy per se nor

changes in energy per se except when connected with a receiver system. Information is a process, an event.

Proposition 1 is a general definition which is independent of the classification of the system: the system could be any biological or social system or even a physical system such as a computer. The control system of a man is the brain with its nerve system; changes in that system contain information. The model covers also the internal generation of information in the system such as the thought process in a human being: energy is needed to start the electro-chemical process of thinking.

According to the phases of the work cycle we can talk about different types of information:

1. Input information
2. Process information
3. Output information
4. Feedback information

Proposition 2

The work in the information process is reorganization of parts and/or energy in the control system temporarily or permanently.

This proposition includes the organization principle of the mathematical and semantic information theories. The exact nature of the work process of the human mind is not known but the proposition is general enough to be operational.

Proposition 3

The information value of the reorganization of the information process is directly proportional to the permanence of the reorganization in the use of the system, and inversely proportional to the amount of equivalent reorganization in the use of the system.

In this proposition we have added a new dimension to the concept of information: permanence or durability or even availability of the reorganization. The amount of equivalent reorganization corresponds with the idea of redundancy of the mathematical information theory. However, equivalent does not mean similar: the same thing can be said in many ways and still mean the same. Equivalent here means logically the same idea.

According to the proposition the maximum amount of information occurs with reorganization which does not have equivalent organization in the system and remains permanently available to the system. The minimum of information occurs with reorganization which has much equivalent organization in the system and disappears immediately from the system.

The dimension of time is a necessary addition to the concept of information. It seems to be against common sense that such surprises as misprints would contain much information as the mathematical information theory implies. But if the idea of permanence of the information is accepted, then there is no contradiction: a surprising event which is not stored in the system has no information value.

Another matter is that there might be an obsolesence factor connected with the permanent information: the "absolute" information value may diminish gradually with time.

The relations of Proposition 3 can be given in the formula:

$$I_v = \frac{P}{E}$$

where:

I_v = information value of the reorganization to the system

P = Permanence of the reorganization available to the system

E = Equivalence: the amount of equivalent

organization in the system.

Proposition 4

Information can be regarded as a three-level hierarchy according to the generation of the work cycle of the control system: 0-level information is generated by random reorganization, 1-level information is generated by the control system itself and 2-level information by the environment of the control system. The lower levels of the hierarchy are always present in the first and second levels of information hierarchy.

0-level information corresponds with the noise-concept of Shannon's theory: it is random noise and it is always present in the work of the control system. 1-level information is generated by the control system itself on purpose as in the thought process. It can also be genetic information (DNA) or information generated by the functions of the body. 2-level information is generated outside the control system as energy from the physical environment and perceived by the senses in the case of a human information process.

The System Model of Information and Communication was published for the first time in a book about the Finnish broadcasting system and its audience: Wiio, O.A.: Yleisö ja Yleisradio, Helsinki 1971 (in Finnish) and Wiio, O.A.: Rundradion och Allmänheten, Helsinki 1972 (in Swedish).

The models in this paper are further developments of the original models.

2.0 A System Model of Communication

In Alfred G. Smith's book Communication and Culture (1966) John B. Newman gives an analysis of different definitions of communication. There are many definitions but none is generally accepted. Some definitions are tautological, some in contradiction with empirical evidence. He concludes that "if any definition is possible, it must be descriptive and pragmatic."

We offer a system model of communication. It could be simply stated that communication is exchange of information between systems. For some purposes this would seem to be enough but we may get into difficulties if we are asked to define the boundaries of a system. Sure enough, if there are two persons talking, it would seem obvious that there are two biological systems interchanging information. However, they could as well be described as one single communication system: there are two objects which have a relationship - namely information. The argument is more obvious if we consider mass communication instead of personal communication. A newspaper with its readers is more likely a communication system than communication between systems.

There are cases where information is exchanged between clearly independent systems as when the systems are far apart in time and/or space. If we read a book printed two hundred years ago in a foreign country, we hardly qualify as a system with the publisher although we are willing to admit that communication takes place. It would seem, therefore, that a system model of communication should include both the cases described above: interchange of information between systems and inside a system.

The main conditions for the system model of communication are:

1. Communication is based on the process of information as given in Proposition 1.
2. Communication can occur between systems.
3. Communication can occur inside a system which then can be regarded as a communication system.

Proposition 5

Communication is an interchange of information between systems or parts of a system where output information from one or several control systems cause work processes in one or several other control systems.

This system model proposition covers interchanges of information regardless of the size or nature of the systems involved. The system can be of the same kind as in the human dialogue or they may be different as in the case of communication between man and a computer. The essential elements in communication are information and control systems. Basically communication is interchange of information between control systems.

Simple human communication systems are social sytems: human beings linked together by the interchange of information. Complex human communication systems are socio-technical systems, where social systems are combined with physical systems as in the case of a newspaper or a broadcasting company.

Proposition 6

A communication system includes the sender (control) system, a communication channel to

carry information, and the receiver (control) system. The sender system originates output information which causes information processes in the receiver control system. The flow of information to the receiver system is regulated by the possible feedback information to the input of the receiver control system and/or to the input of the sender control system.

The model suggested above is more or less the traditional model of communication expressed in system terms.

Proposition 7

Information in the communication process is 2-level information, where the energy changes that start information processes in the control system come from outside the receiver system. This means that information levels 0 and 1 are also present in the communication process: there is always random reorganization and the final reorganization in the receiver control system is generated by the receiver control system itself.

Proposition 7 is very important in the theoretical analysis of a communication system. The proposition means that there is always noise in the communication process. It also means that the final process of information in the control system is generated by the system itself: only the stimuli for information processes can come from outside the control system.

.1 Open and Closed Communication Systems

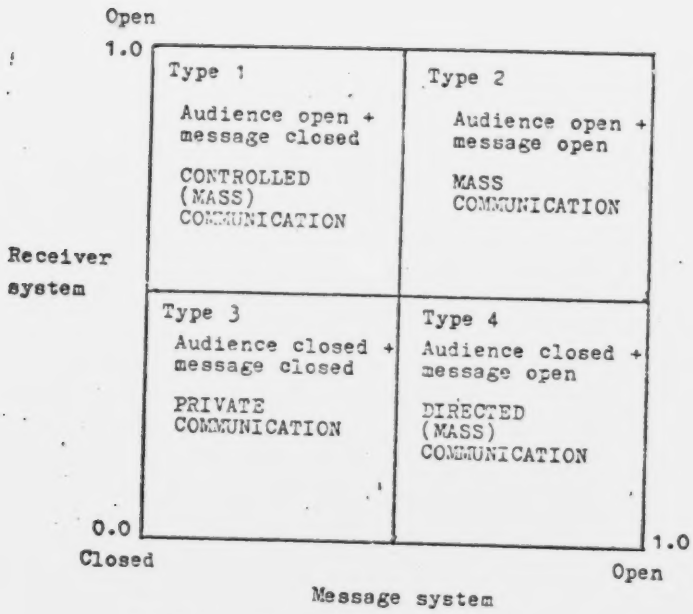
Like systems in general, communication systems can be open and closed. A human communication system is, however, always open and we should speak about relatively open and relatively closed systems. For practical purposes, however, we use the terms open and closed systems.

There could be several criteria for the judgement of the openness of a human communication system. However, in the analysis of the nature of human communication systems and particularly mass communication systems the most relevant criteria seem to be the receiver and message systems: what are the constraints of these systems?

Proposition 8

In an open communication system the receiver system is as free from constraints as possible: the selection of the receivers is unpredictable. The message system is also as free from constraints as possible: the selection of messages is unpredictable.
In a closed communication system the receiver and message systems have many constraints and the selection of the receivers and messages is predictable.

A human communication system is a relatively open system but there are degrees of openness. In a relatively open communication system anybody within the reach of the system is free to join or leave the system and there are few constraints for message content. The functions of the system are difficult to predict. On the other hand, in relatively closed human communication systems there are intended or unintended constraints for the selection of the audience and the messages.



Typology of open and closed communication systems.

The relative openness of the communication systems can be regarded as in the table above. The relative openness is expressed as a value between 0 and 1. The value 1.0 of the audience criterium means that there are few constraints for the audience to join or leave the system and the audience system is unpredictable. The value 1.0 of the message criterium means that there are few constraints for the selection of messages and their content: the messages are unpredictable.

Four main types of communication systems can be derived from the table. It is evident, however, that the types are not clear categories: the systems represent a section of a scale rather than a point.

Type 1: Controlled (Mass) Communication

Controlled (mass) communication means a communication system where the audience system is as open as possible but the message system is relatively closed. The constraints of the message system may be political or any other type which limit the selection of messages.

If the mass nature of the communication system is important then we may call the system Controlled Mass Communication. Such mass communication systems can be found in countries where anybody can join the audience system of the mass media but there are strict political restrictions of the message content.

Type 2: Mass Communication

A mass communication system is a system where both the audience and message systems are as open as possible: there are few constraints in the selection of the audience or messages. This system comes closest to the traditional view of mass communication. It is typically represented with such media as BBC and the New York Times.

Mass communication fits very well inside the definition of a system: mass media and their public have relationships through information. A mass communication system can be described as an open socio-technical system. The sender and receiver systems form the process part of the system which receives an input from the environment: information, human resources and flows of energy, material and money. The output of the system is changes in opinions, attitudes, behavior and knowledge of the people involved in the system as well as flows of energy, material and money. The feedback of the system includes the norms

of the political, economic, religious, ethical etc. systems which return error information back to the process.

The model is not a model of mass communication as such without further elaboration of system properties. For a closer look we have to take a critical view of the traditional definitions of mass communication and mass media.

Gerhard Maletzke (1963) has analyzed the definitions of mass communication and according to him the common properties of the definitions are: public message, technical means of transmission, indirect and one-way communication and undifferentiated and anonymous audience. However, if one tries to apply these properties to modern communication systems, we run into difficulties. Are sound records mass media? Are videotapes mass media? Is a two-way cable television system a mass media system? When is audience anonymous?

There are always constraints of the audience: somebody cannot read and thus he cannot read newspapers; some people are poor that they cannot buy even the most simple radios and thus cannot be members of the radio audience. There will be quite strong economic constraints for a long time to prevent the use of such new media as videotape and cable television. There are also constraints of interest, place and time. In short: the undifferentiated and anonymous audience is a theoretical fiction.

Another argument can be started about the question of one-way communication. It is partly right but only just. In all systems of mass communication there is a feedback and control system which returns feedback information back to the system. It is true that the communication is not a dialogue, but even then it is only a question of degree. For a commercial mass media system the number of the audience is an

efficient form of feedback. For publicly owned mass media the letters and phone calls of the audience, comments in other media and social control systems through political parties etc. form another type of feedback. There may exist in the future mass media with direct feedback from terminals at home.

Thus some kind of new models are needed for mass communication to explain new forms of communication technology. We offer a new model for mass communication based on the idea of open and closed systems:

Proposition 9

Mass communication is an open communication system, where the same message from a single sender system is transferred through the use of media to several receiver control systems and the possible feedback information circulates mainly in the receiver system and only partly returns to the sender system.

According to this model a mass communication system has the following properties:

1. The communication system is open as defined in Proposition 8.
2. There is a single sender system: a radio company, a publisher etc. 2.2
3. The same message must be sent from a single source.
4. The use of media is essential.
5. The feedback is possible but it mainly circulates in the receiver system and only partly returns back to the sender system.

Type 3: Private communication

The opposite of mass communication is private communication where both the audience and the message systems are relatively closed. Typical examples are private letters and phone calls, point-to-point radio communication and many types of business communication.

Type 4: Directed (Mass) Communication

Directed communication means a communication system in which the audience system is closed but the message system open: there are few constraints in the selection of the messages but not everybody can join the communication system. The constraints of the audience system can be intentional or non-intentional: e.g. there is a non-intentional economic restriction on expensive communication systems such as colour television.

If the mass nature of the communication system is important then the system can be called directed mass communication.

2.2 Are there Mass Media?

If the traditional concept of mass communication is obsolete then the concept of mass media is even more so. In fact it can be argued that there are no such things as mass media. Any medium that can be used for mass communication can as well be used for any other type of communication. The media are only media, there is nothing mass or private in them.

It may be useful to have a classification of the media. It cannot, however, be based on the size of the audience but rather on the nature

of the media. The media can be roughly divided into two main types according to the type of the method used to transfer the message. The information can be carried with matter or energy. When matter is used it is transformed in some way to include the desired information: letters in printing, grooves in records and magnetic changes in magnetic tapes. When energy is used it is modulated (changed) to include the desired information: radio energy in FM radio, electric currents in telephone communication and light in laser communication.

Thus we have matter media and energy media. However, the names do not sound operational and we suggest the name imprint media for"matter media" and telemedia for "energy media".

When the media types are combined with open and closed communication systems we get the following table:

	Open Systems: Mass Communication	Closed Systems: Private Communication
Telemedia	Television Radio broadcasting Public cable television	Closed circuit television Telephone Point-to-point radio
Imprint Media	Newspapers Magazines Books Sound records Movies Videotapes Soundtapes	Telex Private letters Recordings for own use House publications

3.0 Conclusion

These system models of information, communication and mass media are offered in the hope that a more unified approach to communication could be evolved. The main thing is not whether these models are accepted or not but that some agreement could be reached about the uses of the basic concepts of the communication process.

The models are hierarchical models: systems within systems within systems. The model building starts with the model of the information process as the work cycle of the control system of a system. When the information process is started by another control system we have communication. When the information process of a number of control systems is started by a single sender system then we have mass communication. This simplified picture illustrates the relationships between the basic concepts of the communication process.

There may be objections against the model of the information process, which turns information into a combination of energy changes and changes in the receiver system. Our argument is, however, that the net result may be operational for pragmatic analysis of communication systems. This is not always true of the traditional theories of information.

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